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GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

Highway Planning and Research
Department of Transportation
St. John's, Newfoundland

# AN EVALUATION OF THE DEPARTMENT OF TRANSPORTATION HYDROSEEDING METHODOLOGY RESEARCH REPORT NO. 32

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TABLE OF CONTENTS


| | Page |
|---|---|
| SUMMARY | i |
| INTRODUCTION | 1 |
| HYDROSEEDING - WHAT IS IT? | 2 |
| THE HYDROSEEDING PROCESS | 4 |
| NEWFOUNDLAND AND LABRADOR'S PRESENT STATE | 6 |
| A. Rationale for Hydroseeding | 6 |
| B. The Present State | 9 |
| WATER EROSION | 11 |
| A. Raindrop Splash | 12 |
| B. Surface Flow | 13 |
| SEED MIXTURES | 14 |
| SOIL TESTING | 16 |
| A. Limestone Requirements | 16 |
| B. Fertilizer Requirements | 17 |
| GUIDELINES FOR A METHODOLOGY AND PROCEDURE | 19 |
| A. Site Selection | 19 |
| B. Preparation of Surface and Slope | 19 |
| C. Mulching | 19 |
| THE HYDROSEEDING PROCESS AND EVALUATION | 21 |
| A. The Process | 21 |
| B. The Evaluation | 21 |
| THE HYDROSEEDING EVALUATION - YEAR 1 | 23 |
| CONCLUSIONS | 35 |
| RECOMMENDATIONS | 36 |
| REFERENCES | 40 |
| BIBLIOGRAPHY | 41 |

APPENDICES

A. The Department of Transportation Hydroseeding Specification

B. Calculation of Net Present Value of Each Alternative's Cost

C. Raindrop Splash

D. Photographs of Site Prior to Hydroseeding

E. Soil Sampling Procedure Used by the Department of Agriculture for Agricultural Land

F. Soil Test Report

G. Photographs of Hydroseeding Machine

H. Photographs of Site After Hydroseeding

I. Photographs of Frame Used to Estimate Turf Grass Cover

J. Photographs of Site After Grass Cover is Established

K. Hydroseeding Evaluation Questionnaire

SUMMARY

The establishment of turfgrass on roadsides is an integral part of road construction. As well as providing an economic basis of maintaining the right-of-way and controlling erosion, turfgrass is a fast and effective means of healing the scars of construction and creating a visually satisfying roadside.

A technique for estimating turfgrass cover and a Hydroseeding Evaluation Questionnaire are introduced as methods to determine the establishment rate and general appearance of the grass. These techniques should be used periodically, with emphasis in the early stages of the hydroseeding project to assess project effectiveness.

The Department of Transportation should consider changing its Roadside Seed Mix to reflect current industry standards which include a percentage of legumes in the seed mixture. As well, specifics relating to lime and fertilizer requirements in the Hydroseeding Specification should be changed to better reflect site specific requirements.

Grading of slopes should be done immediately prior to slope and surface preparation and natural topsoil should be set aside during construction for use in revegetation.

Better coordination and communication is needed between the Department of Transportation, Department of Agriculture and the contractor.

Finally, an evaluation of this site should be continued to include an analysis of years 2 and 3 in the Evaluation Process.

## INTRODUCTION

All construction activities disturb the soil on which they occur and destroy the protective vegetative cover over much of the area. Such disruption leads to soil erosion which has implications both environmental and aesthetic and on the stability of the road structure.

This report is a follow up to the report entitled Recommended Guidelines for Hydroseeding Methodology and Procedure (August, 1983) by Heather Skanes. Ms. Skanes established guidelines for a methodology and procedure to evaluate hydroseeding projects. These guidelines will be the basis for this report.

The purpose of this report is to undertake an evaluation of a hydroseeding project and to make recommendations as to any necessary changes and/or improvements in the hydroseeding process.

The evaluation has been limited to the use of only one seed mix - the Newfoundland Roadside Seed Mix. Experience has shown that the problem with seed not growing may not be due to problems with the seed mixture itself, but due to insufficient amounts of topsoil, lime and fertilizer. It was therefore decided that only one seed mix would be used by the Department of Transportation in hydroseeding.

HYDROSEEDING - WHAT IS IT?

Hydroseeding is "a specially sprayed slurry of well mixed combination of turf making materials such as water, sprig or seed, fertilizer, wood cellulose and even compatible insecticides... providing a fast quality turf in a fraction of the time formerly required... and even under most adverse conditions".(1:1)

Construction often causes a disturbance of highway right-of-ways. Erosion is encountered which leads to the eventual sedimentation of water courses and deposition of silt in ditches. Subsequently, if no corrective action is taken, a situation will develop whereby water ponding and saturation of the subgrade occurs which will cause a breakup of the road surface. Accelerated erosion leads to poor aesthetic qualities and poor definition of the roadside which is required for highway safety. To remedy these problems, a quick growing vegetative cover is required, as soon as possible, to stabilize the slopes bordering the newly constructed highways.

The hydroseeding project, by virtue of its adaptable equipment, sprays the slurry thus reaching these problem areas as well as providing a quick establishment of a vegetative cover which will stabilize slopes. This stabilization, in turn, reduces the amount of erosion while the vegetative cover aids in providing much desired aesthetic qualities. The grass clearly differentiates the roadside from the roadway.

Not only is the environment preserved and the safety of motorists ensured, but through providing a vegetative cover by hydroseeding, cost and labour requirements are reduced. Hydroseeding then, is quick, effective, and economical.

Therefore, hydroseeding can be defined as a process which reduces seeding application time while still providing an adequate basis for revegetation.

## THE HYDROSEEDING PROCESS

Reseeding grasses and legumes on a prepared site are relatively straightforward and simple tasks. But preparing the site for seeding and protecting it until the planted vegetation can do so is complicated.

In general, topsoil is spread over the surface of the exposed areas during or after construction is complete. Soil samples are taken and tested for lime requirements and available phosphate, potash, calcium and magnesium.

Two operations are employed in the hydroseeding of designated areas. The first operation consists of the distribution of a slurry composed of grass seed, fertilizer, lime and binder.

The second operation consists of the distribution of a slurry composed of mulch, plus binder.

Both operations require that the ingredients be thoroughly mixed with water in a hydroseeding tank. The mix is continuously agitated during the hydroseeding operation to ensure that a homogeneous slurry is produced.

The distribution of the slurry is by means of an approved hydroseeder and is applied uniformly and in such a manner as to prevent puddling and movement of the soil surface.

The sooner a turf cover can be obtained, the better. But as road construction continues throughout the construction season, new areas will often be exposed for several months before seeding. Therefore, in erosion prone areas, a mulch should be applied immediately after construction rather than waiting for seeding.

The Newfoundland and Labrador Department of Transportation contracts out hydroseeding projects to private companies who must follow the Hydroseeding Specification, found in Appendix A.

## NEWFOUNDLAND AND LABRADOR'S PRESENT STATE

### A. Rationale for Hydroseeding

Hydroseeding can provide a quick, cheap, effective, and efficient vegetative cover. However, its use must be substantiated by comparing its monetary and non-monetary costs and benefits with those of alternatives which do not provide vegetative covering.

When slopes are left uncovered, soil particles become detached and are then deposited in ditches at the foot of the slopes. Eventually, water transports this material to water courses. To eliminate this problem, the activity Ditch Cleaning must be undertaken. If ditch cleaning is not employed, a disturbance of the highway's subgrade, due to water penetration will follow leading to deformation of the travelled surface and its associated safety problems. Furthermore, a long list of conflicts with other departments will be encountered. For example, the Department of Fisheries will be concerned with the impact that sediment will have on fish and fish habitat. Likewise, the Department of the Environment would be concerned with the deterioration of water quality due to sediment transport.

Thus, to avoid such problems, not only would drainage cleaning have to be undertaken, but it would be required annually in order to deal with these problems as effectively as hydroseeding does. However, constrained by capital

costs, the Department of Transportation engages in drainage cleaning approximately every three years.

Realistically speaking, hydroseeding cannot totally control erosion; therefore some build-up in ditches will occur necessitating ditch cleaning every seven years.

Referring to Table I, below, the net present value of the hydroseeding alternative, over a 15 year period, for drainage cleaning is $4,456.46/km as compared to the three year ditch cleaning alternative of $12,869.00/km. Thus a capital saving of $8,412.54/km is retained in the drainage cleaning account.

TABLE I: NET PRESENT VALUE OVER FIFTEEN YEARS ($/KM)

| ALTERNATIVE | INITIAL COST | DRAINAGE COST | RESURFACING COST | TOTAL COST |
|---|---|---|---|---|
| *I Hydroseeding | $8,488.80 | $ 4,456.46 | $ 76,396.80 | $ 89,342.06 |
| IIa) Annual Ditch Cleaning | Nil | 42,594.16 | 76,396.80 | 118,990.96 |
| b) 3 Year Ditch Cleaning | Nil | 12,869.00 | 96,268.70 | 109,137.70 |
| c) No Ditch Cleaning | Nil | Nil | 119,596.80 | 119,596.80 |

NOTE: detailed calculations can be found in Appendix B

Source: Skanes, Heather Recommended Guidelines for Hydroseeding Methodology and Procedure

If neither ditch cleaning nor hydroseeding is utilized, then no cost will be incurred. However, looking one step further, these alternatives have implications for another activity, Resurfacing.

Theoretically, this activity is undertaken every five to seven years, depending upon the condition of the highway's subgrade. In turn, the subgrade's condition is affected by the buildup of silt and other materials. Thus, if annual drainage cleaning or hydroseeding is employed, the full life of the surface is attained resulting in a need for resurfacing approximately every seven years. However, the alternative of cleaning ditches every three years, would require complementary resurfacing on an average of every six years. No drainage cleaning would require resurfacing at the minimum of every five years.

Thus, making these assumptions, if hydroseeding is employed the associated resurfacing cost is $76,396.80/km; whereas if the realistic alternative is considered, the cost if $96,268.70/km. This is a savings of $19,871.90/km over 15 years which will be retained in the resurfacing account.

Overall then, hydroseeding, even though it has the greatest initial outlay, has the least long-run monetary cost given that the appropriate management of the highway

surface is employed. As well, most will agree that grassy, vegetated slopes are much more attractive than scraggy, sterile landscapes, typified by unvegetated, unstable slopes. This non-monetary benefit, coupled with the avoidance of interdepartmental environmental conflicts, boosts the rationale for hydroseeding.

B. The Present State

The previous portion of this section demonstrated the practicality of hydroseeding. However, if this operation does not fulfil its intended purposes, then unforeseen costs will be incurred. Therefore, it would be logical to seek alternatives if these extra-ordinary costs exceed the difference between hydroseeding and not providing a vegetative cover - the margin on which the decision was based.

Unfortunately, consistent successfulness has not been attained on hydroseeding slopes bordering Newfoundland and Labradors' highways. For example, in the vicinity of Come-By-Chance, erosion is plaguing the slopes causing a build-up of silt in the ditches. Also, the bare areas are no less than eyesores.

However, better results have been attained in the Clarenville area. As well, other provincial governments have found hydroseeding to be effective and efficient.

The unsatisfactory results are not necessarily consequential of failures in the hydroseeding technology; rather one of a multitude of reasons may have been the cause. These problems include: engineering of slopes, lack of sufficient drainage, seed mixtures used, the slope, time of year, fertilizer, or even neglect on part of the contracted company. Thus, involved documentation and monitoring of each project are required in order to ascertain and to avoid difficulties. Similarly, follow-up inspections of hydroseeded areas should be made, from time-to-time, even after the project has been concluded. Such information is invaluable to future undertakings.

## WATER EROSION

Erosion is the wearing away of the land surface by water, wind, ice and other geologic agents, and the transport and deposition of the weathered material. It is a natural process.

Much erosion continues to be "natural", however, in other areas man has altered this natural process by accelerating the rate and amount of erosion particularly through careless deforestation and agricultural and construction practices.

The major problem along Newfoundland and Labrador highways is water erosion. Sediment produced by erosion accumulates in and reduces the capacity of reservoirs; restricts stream flow, increases flood hazards and increases turbidity which alters aquatic systems, affects fish life and increases water treatment costs. Erosion can lead to road washouts and further road deterioration. The deposition of soil from eroded backslopes may cause water levels in ditches to rise and subsequently accumulate in the roadbed. When this water freezes the road surface is subjected to frost heaves and quickly deteriorates.

There are two principal types of soil movement in the water erosion process. They are known as raindrop splash and surface flow.

A. Raindrop Splash

The energy of the falling raindrop blasts the soil particles apart at the point of impact, and splashes bits of soil and organic matter into the air. This is referred to as raindrop splash.

It has been found that more than 150 tons of soil an acre may be splashed by a one-inch beating rain on a highly erodable soil.(2:70) When falling raindrops strike bare soil they destroy the crumb structure of the surface layer which results in puddling and sealing of the surface. This shuts out water and results in excessive run-off. The maximum amount of damage is done during periods of heavy impact storms when the falling raindrop and surface flow team up on bare land. The raindrop dislodges and splashes the soil particles and organic matter into the air to fall back in the surface flow and be swept down the slope.

The secret of controlling erosion caused by the falling raindrop is the dissipation of the energy contained in the raindrop before coming in direct contact with the ground surface. This is accomplished under natural conditions by forest and grass cover. Erosion control should follow nature's methods and keep soil protected by vegetative cover. See Appendix C for pictures of raindrop splash.

B. Surface Flow

Flowing water erodes the soil by a scouring action. The amount of force generated by surface flow is related to the concentration and velocity with which water moves downhill.

The secret of reducing the damage caused by surface flow is to control the water's concentration and to retard or regulate its velocity. The regulation of both the concentration and the velocity with which free water moves over the surface of the ground may be accomplished by controlling the length of slopes over which the water moves. When this is done in combination with good soil management and plenty of grasses and legumes to increase organic matter and improve the crumb structure of the soil, losses from water erosion will be largely controlled.

SEED MIXTURES

The prime requirements of erosion control plants are that they sprout and grow rapidly and that they maintain erosion protection through all extremes of the climate.

Grasses are commonly used because they provide cover quickly. The fibrous root mass and dense stems hold the soil against wind and water. Grasses improve soil structure, increase the organic matter, and help to build up soil fertility.

Legumes are plants which are capable of converting atmospheric nitrogen into chemical forms for plant use. Thus if soil is nitrogen deficient, legumes require less additional nitrogen than grass species; therefore they would prove to be beneficial in areas which are hard-to-get-at for fertilization.

Legumes mixed with grasses improve the soil faster than grasses alone because the legumes add nitrogen to the soil. The fibrous roots of the grasses improve the crumb structure of the soil and the deep tap roots of the legumes push down and open up the subsoil where they utilize the moisture and minerals, which are not available to the more surface rooting grasses.

Most research suggests that different seed mixtures be used depending on local conditions such as seasonal weather changes, precipitation, slopes and soils. The Department of Transportation, however, uses only one seed mix comprised entirely of grasses (g):

50% Creeping Red Fescue (g)

30% Kentucky Bluegrass (g)

15% Colonial Bentgrass (g)

5% Timothy (g)

While using the proper seed mixture is important in controlling erosion, from an ecological viewpoint, the regrowth of natural vegetation should be encouraged.

## SOIL TESTING

A primary step in a hydroseeding project is a soil test which indicates lime and fertilizer requirements. Soil samples are taken by the Department of Transportation Soils Lab and forwarded to the provincial Department of Agriculture for testing. Every geographic area has unique soil conditions, thus it is important to soil test every time a hydroseeding project is undertaken in order to determine the conditions characteristic of that area.

The soil sample must be representative of the area to be seeded; therefore several random samples of 227 millilitres each should be mixed together. 454 millilitres are then needed from the mixture to provide the ultimate sample soil.

One of the tests which is administered is a ph test. This test determines the acidity of the soil. Most virgin soils and forest areas have a ph of 4 - 4.5 in a possible range of 0 - 14 with 1 being the limit for maximum acidity. Grasses generally require a ph of at least 5; whereas legumes require a ph of 6 - 6.5. To increase the ph (ie. decrease the acidity of soil) limestone is required.

### A. Limestone Requirements

Limestone serves several functions:

(1) It reduces toxic levels of soluble aluminum and manganese.

(2) It encourages the activity of soil bacteria thus releasing valuable nutrients such as nitrogen, phosphorus and sulphur from organic components within the soil. In the case of legumes, it also stimulates the nitrogen fixing bacteria in root nodules.

(3) Through several processes, it stabilizes soil aggregates and renders the soil more resistant to erosion.

(4) It supplies calcium and magnesium for crops.

The importance of liming cannot be overlooked. Newfoundland's present specification requires that lime be added in a quantity which will bring the ph level to 6.5. If lime is added in required quantities, then the stands will have a better chance to succeed in providing erosion control. Obviously, if lime is not applied in required quantities, a failure will result leading to additional costs to be incurred for repeated project operations.

B.Fertilizer Requirements

Plants require nutrition as well as an acceptable ph level in order to grow and function properly. The major nutrients include: (a) hydrogen, oxygen and carbon which are supplied by air and water; (b) nitrogen, potassium, phosphorus, calcium and magnesium which are supplied by the soil.

Nitrogen (N), phosphorus (P) and potassium (K) are provided by fertilizer while magnesium and calcium are supplied by limestone.

Newfoundland's specification requires the addition of a fertilizer with an analysis of 16-32-6. That is; a ratio of 16N to 32P to 6K.

## GUIDELINES FOR A METHODOLOGY AND PROCEDURE

### A. Site Selection

Several criteria should be considered when selecting sites for evaluation. These include accessibility, visibility, and freedom from vandalism. Ease of accessibility is required in order to evaluate the area. Visibility for motorists is also essential. Evaluating the stands should include the opinions of members of the public. Finally, areas must be chosen that are free from potential vandalism or any other activity which would destroy the site.

Thus, prime locations would be spacious slopes with continuous soil conditions which are in the view of motorists and accessible for evaluation.

### B. Preparation of Surface and Slope

Due to Newfoundland's high levels of precipitation, preparation of the soil surface and engineering of the slope are prerequisites to successful hydroseeding operations. Therefore, the Hydroseeding Specification - Preparation of Surface - should be followed closely (Appendix A).

### C. Mulching

Mulch is essential in establishing good stands of grasses and legumes on steep cut-and-fill slopes and other areas where it is difficult to establish plants.

Mulching performs several functions:

(a) minimizes soil erosion from both surface running water and the impact of raindrops.

(b) minimizes seed and seedling displacement by wind and water.

(c) provides favourable temperature and moisture conditions for seed germination and seedling growth.

(d) extends the seeding season over the summer months when periods of temperature and moisture stress are frequent.

Straw or hay are the preferred mulches in roadside hydroseeding. However, wood fibres, wood chips, shredded newspapers, and waste raw cotton have been introduced to the market.

The mulching operation is outlined in the Hydroseeding Specification to follow the application of the slurry of seed, fertilizer, lime, and binder (Appendix A).

The binder, which is mixed in a slurry with the mulch, is an adhesive integrating the mulch to the soil.

## THE HYDROSEEDING PROCESS AND EVALUATION

### Year 1

### A. THE PROCESS

Step 1: Site Selection

Step 2: Site Preparation

(i) Slope and Surface Preparation - includes grading and the laying of organic material (ie. topsoil or peat).

(ii) Plot Layout - A plot layout was recommended by Skanes (3:37) whereby several seed mixtures were tested. Only one seed mixture is used by the Department of Transportation, thereby eliminating the need for this step.

(iii) Soil Sample - an explanation of the sampling procedure and the test results will be given.

Step 3: Hydroseed - Application

(i) Apply slurry of lime, fertilizer, seed mixture, and binder.

(ii) Apply slurry of mulch and binder.

### B. THE EVALUATION

Step 4: Follow-up: Maintenance and Evaluation

(i) Assess Establishment Rate

(ii) Assess General Appearance (30 days and 60 days after hydroseeding)

(iii) (a) Take Soil Samples (Mid-August)

(b) Assess General Appearance

(iv) Assess General Appearance (Before Snowfall)

Year 2

Step 5: Follow-up: Maintenance and Evaluation

(i) (a) Soil Samples (Mid April - Mid May)

(b) Assess General Appearance

(c) Assess Winter Hardiness

(ii) (a) Soil samples (Mid July - Mid August)

(b) Assess General Appearance (Before Snowfall)

Year 3

Step 6: Follow-up: Maintenance and Evaluation

(i) (a) Soil Samples (Mid April - Mid May)

(b) Assess General Appearance

(c) Assess Winter Hardiness

(ii) (a) Soil Samples (Mid July - Mid August)

(b) Assess General Appearance (Before Snowfall)

Step 7: Assess Erosion Control Abilities

An evaluation of Year 1 only (Steps 1 to 4) will be included in this report.

## THE HYDROSEEDING EVALUATION - YEAR 1

### Step I: Site Selection

The north facing slope on the Trans Canada Highway eastbound lane (entering St. John's) at the beginning of the divided highway just east of the Foxtrap Access Road was selected for evaluation. East Coast Hydroseeding Ltd. was awarded the contract.

This site was selected by Roger Pottle, Environmental Planner and the author. The site was selected for its accessibility, visibility, and freedom from vandalism. Its location was approximately 10 km outside the St. John's city limits and was easily accessible and visible for evaluation. The area was located along a major divided highway free from pedestrians and urban areas thus decreasing the possibility of vandalism.

See Appendix D for photographs taken of the site prior to hydroseeding on May 3, 1985.

### Step 2: Site Preparation

(i) Slope and Surface Preparation - The site was graded with any existing topsoil spread over the area after the construction of the road in 1984. Grading the slopes so far in advance of hydroseeding resulted in the loss of some organic material that was present. As a result, more peat was required.

Beginning May 24, 1985, peat taken from a quarry immediately south of Paddy's Pond Irving was spread

over any existing topsoil. The slope, after peat was laid, had a rough, damp surface with open drainage. Twigs and small rocks were evident. The surface appeared to have good potential for the seed to root.

(ii) Soil Sample - A soil sample was taken in September, 1984 by the Department of Transportation Soils Lab and sent to the Provincial Department of Agriculture for testing.

The Department of Transportation Soils Lab has no formal procedure for taking soil samples pertaining to hydroseeding operations. The method employed was to dig a hole and fill a bag with the organic material. Such a sample was not truly representative.

The Department of Agriculture recognizes that proper sampling of the soil is exceedingly important. They have a soil sampling procedure used for agricultural land which can be seen in Appendix E. The Department of Transportation should establish its own procedures for taking soil samples for hydroseeding projects using the Department of Agriculture instructions as a guideline.

The soil test report, as seen in Appendix F, indicates the soil ph and the levels of phosphate, potash, calcium and magnesium in the soil.

The treatment suggested by the Department of Agriculture for peat was to apply 8 tonnes of limestone per hectare and approximately 1000 kg of 6-12-12 fertilizer per hectare.

The Department of Transportation requirements for the application of fertilizer and limestone were 600 kg/ha of fertilizer having a plant food ratio of 16 nitrogen, 32 phosphorus and 6 potash (16-32-6) and any amount of lime required to bring the ph level to 6.5.

East Coast Hydroseeding used 600 kg/ha of fertilizer as per the Department specifications but altered the plant food ratio to 16-32-16. The potash content was increased from 6 to 16 because it is a nutrient that is necessary to the plants and that is absorbed quickly. The contractor used 5 tonnes/ha of limestone.

The amount of fertilizer used by East Coast Hydroseeding does not coincide with the amount recommended by the Department of Agriculture. The Department of Agriculture recommended that 1000 kg/ha of 6-12-12 be used whereas 600 kg/ha of 16-32-16 was used. A high quantity of a low percentage fertilizer was recommended but a low quantity of a high percentage fertilizer was actually used and,

according to the Department of Agriculture, this balances out the two. However, concern was expressed by a representative from the Department of Agriculture that the unequal amounts of phosphorus and potash (ie. 32% phosphorus and 16% potash) may cause burning of the grass. To avoid this problem, equal amounts of phosphorus and potash should be used.

East Coat Hydroseeding used approximately 5 tonnes/ha of limestone as compared to the Department of Agriculture recommendation that 8 tonnes/ha be used. East Coast Hydroseeding did their own ph tests following the grading operation and explained that a lesser amount of limestone was used because these tests showed higher readings (5-6) than were found by Department of Transportation sampling (4) thus requiring less lime to increase the ph. Also, the grading operation blended the peat with the subsoil thus changing the ph.

Sinnot's Hydroseeding was awarded a contract to hydroseed the median on the Trans Canada Highway just east of the Chalet Lodge (km 15) to just east of the Foxtrap Access Road (km 23) and the interchange for the Cochrane Pond Provincial Park Overpass. Hydroseeding began in June, 1985. Sinnot's Hydroseeding took their own ph samples and applied

approximately 10.35 tonnes/ha of lime. After liming, the ph of the peat increased to 8.5 which was too high. The provincial Department of Agriculture advised them to grade the peat into the subsoil to lower the ph. After grading, a subsequent soil sample indicated the ph level was reduced to 7.

Sinnot's Hydroseeding used 5000 kg/ha of 16-32-6 fertilizer as per the Department of Transportation Specification. However, the contractor voiced concern about the fertilizer used. Based on their experience in the Province the contractor indicated a fertilizer with a nutrient breakdown of 12-24-24 has given them the best results.

Obviously, there is disagreement as to lime and fertilizer requirements between the Department of Transportation, Department of Agriculture and the contractors. Better coordination and communication is required between these three parties. As well, specifics as to lime and fertilizer requirements in the Hydroseeding Specification (Appendix A) should be changed to reflect actual requirements of the soil prior to the hydroseeding.

A system involving the Environmental Planner, the Soils Lab, and the Design Division must be established to ensure success of meeting soil nutrient requirements.

Step 3: Hydroseed - Application

(i) Apply slurry of lime, fertilizer, seed mixture and binder.

(ii) Apply slurry of mulch and binder.

Hydroseeding began in early July, 1985. The technique used was as per the Department of Transportation Hydroseeding Specification (Appendix A) and as described in the previous section. The Hydroseeding Process.

East Coast Hydroseeding used the Department Roadside Seed Mix which is comprised entirely of grasses. However, based on their experience and accepted industry standards, legumes were added at a ratio of 15% legumes to the seed mixture. The legume content was composed of 40% clover and 60% birdsfoot trefoil. Legumes are used because they improve the soil faster than grasses alone by adding nitrogen to the soil. As well, the deep tap roots of the legumes push down and open up the subsoil where they utilize the moisture and minerals which are not available to the more surface rooting grasses. The addition of legumes was approved by the Design Division of the Deparment of Transportation upon application by the contractor.

Sinnot's Hydroseeding also added legumes to the Department seed mix at a ratio of 5% white clove.

A representative from the Department of Agriculture explained that the addition of legumes would not cause a change in their recommendations for lime and fertilizer requirements.

East Coast Hydroseeding also expressed concern over two of the grasses used in the Roadside Seed Mix - Kentucky Bluegrass and Colonial Bentgrass. These grasses require a large nutrient content and substantial maintenance with regard to mowing and refertilization. For these reasons, Kentucky Bluegrass and Colonial Bentgrass are generally not used extensively in roadside seed mixes.

Based on these concerns, the Department of Transportation should consider changing its roadside seed mix to reflect current industry standards and practice.

The binder used was comprised of straw, cotton, and cellulose as per the Hydroseeding Specification (Appendix A). Wood fibre was used as a mulch.

Photographs of the hydroseeding machine can be seen in Appendix G. Photographs of the site taken on July 10, 1985 after hydroseeding are in Appendix H.

Step 4: Follow up: Maintenance and Evaluation

(i) Assess Establishment Rate - Grass begins to appear 10-14 days after hydroseeding. On July 24, 1985 the site was observed and a technique discussed by

Wakefield and Sawyer (4:7) for estimating turfgrass cover employed. The technique involved placing a frame or quadrat with 5 equal squares of any size at random in the area to be evaluated. The amount of ground covered by perennial grasses in each square is estimated to the nearest value as follows:

Complete ground cover = 4

3/4 ground cover = 3

1/2 ground cover = 2

1/4 ground cover = 1

These five values are added and multiplied by 5 to calculate the percent ground cover. This procedure is repeated to arrive at a consistent value.

For example, if ground cover in each square is 4+3+3+4+3 then the total value (17) multiplied by 5 equals a 85% stand.

A temporary frame of cardboard with the squares measuring 140 cm X 140 cm was used for this evaluation but a more permanent structure could be built of wood.

Photographs of the frame used can be seen in Appendix I.

This technique showed that approximately 2-3 weeks after hdyroseeding 75% of the site was covered with grass. The technique was repeated four times to

arrive at a consistent value and the average value assigned to all five squares was 3. Therefore, the total value of the squares 3+3+3+3+3 (15) multiplied by 5 equals a 75% stand.

This technique should be used every 2-3 weeks in the first three months to determine the establishment rate of the grass in the early stages of the hydroseeding project. The percent of ground actually occupied by perennial grasses should also be evaluated in the early spring or late fall in subsequent years to determine standards for refertilization. Table 2 provides the standards for refertilization.

TABLE 2 - STANDARDS FOR REFERTILIZATION

| PERCENT OF GROUND COVERED BY PERENNIAL GRASSES | FERTILIZER |
|---|---|
| 80 - 100 | None Required |
| 60 - 80 | Fertilizer should be applied within one year. |
| Less than 60% | Fertilize immediately. Overseed areas with less than 50% ground cover. Regrade and reseed if erosion is occurring. |

Source: Wakefield and Sawyer Roadside Vegetation Management

Photographs of the site after grass cover was established are in Appendix J.

(ii) Assess General Appearance - Two groups of people were administered a questionnaire to assess the overall appearance of the hydroseeding project. Group I consisted of people with no technical expertise. Group 2 consisted of people with technical knowledge including:

Construction Engineer

Director of Planning & Research

Maintenance Engineer

District Engineer

Environmental Planner

Soils and Paving Engineer

Crops Coordinator, Department of Agriculture

The questionnaire consisted of 7 statements which were ranked on a scale from 1 to 7 with 1 being a poor assessment and 7 being a good assessment of the hydroseeding project.

This format was considered to be the most effective because the questionnaire dealt with opinions requiring the possibility of various degrees of approval or disapproval. As well, the questionnaire can be administered quickly and the replies can be easily and accurately tabulated. The Hydroseeding Evaluation Questionnaire can be seen in Appendix K.

Group I was administered the questionnaire on August 1, 1985. The overall results indicated the grass had a healthy, green appearance and good, even height. There was no occurrence of weeds and the ditches were empty of silt deposit. However, the participants found that the grass was patchy and erosion scarred in some places. Overall, Group I found the appearance of the grass to be healthy and attractive. The results of the questionnaire given to Group I (ie. those with no technical knowledge) can be seen in Appendix K.

Group 2 was sent questionnaires on July 31, 1985 and requested to return the questionnaires before August 8, 1985. An analysis of the questionnaires received from the technical group indicated that the grass had a healthy, green appearance and good, even height. There was little occurrence of weeds and the grass covered most of the area. Group 2 found the slope was fairly smooth and even and the ditches were empty of silt deposit. Generally, this group found the grass had a healthy and attractive appearance.

(iii)

(a) Take soil samples - Soil samples should be taken approximately three months after hydroseeding. These samples could be taken by the Department of Transportation Soils Lab and forwarded to the

provincial Department of Agriculture for analysis. Depending on the results of the soil tests, apply lime and fertilizer as required.

(b) Assess General Appearance - Approximately three months after hydroseeding, the general appearance of the grass cover should again be evaluated by administering the Hydroseeding Evaluation Questionnaire (Appendix K).

(iv) Assess General Appearance - Prior to snowfall, another evaluation of the turfgrass should be done using the Hydroseeding Evaluation Questionnaire.

## CONCLUSIONS

Uncontrolled water erosion resulting from construction activities causes significant damage to the environment and the roadway. The sediment produced pollutes surface water, restricts drainage, fills reservoirs, damages adjacent land, and destroys the natural ecology of lakes and streams. Erosion also leads to road washouts. Soil deposition from eroded backslopes can raise water levels in ditches and subsequently in the road subgrade. When this water freezes the road surface is subjected to frost heaves and quickly deteriorates. Besides harming the environment and the roadway, soil erosion during construction increases costs and causes extensive delays and repairs.

It is essential that measures be taken to reduce water erosion along Newfoundland and Labrador highways. Hydroseeding has been substantiated as a method of controlling water erosion on the basis that it is more cost effective and provides more non-monetary benefits than other available alternatives.

Better coordination and communication is needed between the Department of Transportation, Department of Agriculture, and the contractor. A soil testing procedure pertaining to hydroseeding is necessary and a process to evaluate a change in the seed mixture should be established.

## RECOMMENDATIONS

The following are recommendations which, if followed, will improve the hydroseeding methodology currently used by the Newfoundland and Labrador Department of Transportation.

1. Grading of the slopes should occur immediately prior to slope and surface preparation to avoid the loss of existing topsoil associated with grading too far in advance of hydroseeding.
2. Natural topsoil should be set aside during construction for use in revegetation.
3. Any organic matter applied to the slope surface should be blended with the subsoil to form a bond between the two layers.
4. Erodible slopes should not be left bare for more than one season or they will require refinishing before seeding.
5. The sooner a turf cover can be obtained, the better. But as road construction continues throughout the construction season, new areas will frequently be exposed for several months before seeding can be done and the grass itself can give erosion protection. Therefore, in erosion sensitive areas a mulch should be applied immediately after construction rather than waiting for the seeding.

6. Based on the contractors' concerns and those of the Provincial Department of Agriculture about the lack of legumes and the nutrient and maintenance requirements of Colonial Bentgrass and Kentucky Bluegrass, the Department of Transportation should establish a process to evaluate a change to the seed mix to reflect current industry standards.
7. Lime and fertlizer requirements in the Hydroseeding Specification should be site specific dependent on soil test results.
8. Depending on soil analysis results, hydroseeded areas should be refertilized in subsequent years to maintain the turfgrass cover.
9. Equal amounts of phosphorus and potash should be used in the fertilizer to avoid burning of the grass.
10. From an ecological standpoint, the regrowth of natural vegetation should be encouraged.
11. The requirements for any hydroseeding project are site specific. The types and amounts of materials required depend on details of soil, slope, exposure, climate and topography.
12. Better coordination and communication is needed between the Department of Transportation, Department of Agriculture and the contractor.

13. The Department of Transportation should establish its own procedures for taking soil samples for hydroseeding projects using the Department of Agriculture instructions as a guideline.

14. The technique used to determine turfgrass cover as outlined in Step 4: Follow-up: Maintenance and Evaluation should be employed every 2-3 weeks in the first three months of the hydroseeding project to determine the establishment rate of the grass in the early stages of the project.

    This technique should also be used in the early spring or late fall in subsequent years to determine standards for refertilization. The standards for refertilization as given in Table 2 of this report should be used as guidelines.

15. Soil samples should be taken approximately three months after hydroseeding by the Department of Transportation Soils Lab and forwarded to the provincial Department of Agriculture for analysis. Depending on the results of these tests, lime and fertilizer should be applied as required.

16. The Hydroseeding Evaluation Questionnaire should be administered twice in the first month of the hydroseeding project, once to people with technical expertise and again to people with no technical

knowledge. This questionnaire should again be administered to the same people three months after hydroseeding and before the first snowfall.

17. An evaluation of this site should be continued to include an analysis of Years 2 and 3 in the Evaluation Process.

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## APPENDIX B

CALCULATION OF NET PRESENT VALUE
OF EACH ALTERNATIVE'S COST

Source: Skanes, Heather Recommended Guidelines for Hydroseeding Methodology and Procedure

Calculation of Net Present Value of Each Alternative's Cost:

Table A: Associated Costs

| ALTERNATIVE | ASSOCIATED COSTS AND INTERVAL |
|---|---|
| I. Hydroseeding | a) Initial Cost in year 1 |
| | b) Drainage Cleaning every 7 years |
| | c) Resurfacing every 7 years |
| II. No Hydroseeding | |
| II.A) Required | a) Annual Drainage Cleaning |
| | b) Resurfacing every 7 years |
| II.B) Realistic | a) Drainage Cleaning every 3 years |
| | b) Resurfacing every 6 years |
| II.C) | a) Resurfacing every 5 years |

The costs of Drainage Cleaning and Resurfacing are expressed in \$/km; whereas Hydroseeding costs are expressed in $\$/m^2$. Thus, the first step is to convert $\$/m^2$ hydroseeding to \$/km hydroseeding.

Conversion of $/m$^2$ to $/km:

Step I: The cost /$m^2$ was found by taking the mean of three recorded hydroseeding contracts costs.

$$\begin{array}{r} \$1.0000/m^2 \\ .4464 \\ .4400 \\ \hline \Sigma \quad \$1.8864 \\ \hline \bar{x} = \$\ .6288/m^2 \end{array}$$

Step II: (i) In order to find the area hydroseeded, the right-of-way and type of highway had to be considered. Only the most common of each are considered. That is, 20 m and 30 m right-of-ways, and Rural Collector Undivided 80 and Rural Local Undivided 80 highways.

In order to calculate the four possible widths of area hydroseeded, the RLU 80 and RCU 80 must be subtracted from each of the right-of-ways. (The right-of-way being the measured distance from the centre of the ditch on left side of the road to the centre of the ditch on the right side of the road)

(ii) As there are 1,000 m/km, length of area per km. this was multiplied by the width of the area hydroseeded yielding a measure of area in $m^2$/km.

(iii) Finally, multiplying the $m^2$/km hydroseeded area by the cost/$m^2$ yields the cost/km of hydroseeded area.

Table B presents the converted figures as well as a sample calculation.

Table B: Conversion of Cost/$m^2$ to cost/km for Hydroseeding

| Highway Type \ Right-of-way | 20 m | 30 m |
|---|---|---|
| Rural Collector Undivided 80: 18.5 m | $943.20/km | $7,231.20/km |
| Rural Local Undivided 80: 16.5 m | $2,200.80/km | $8,488.80/km* |

* Sample Calculation:

Right-of-way = 20.0 m
RLU 80 = 16.5 m
width of area = 3.5 m

Cost/$m^2$ ($\bar{x}$) = $.6288/$m^2$
Cost/km = Cost/$m^2$ x $m^2$/km

$\therefore$ $m^2$/km = 3.5 m x 1,000 m/km
= 3,500 $m^2$/km

$\therefore$ Cost/km = $0.6288/$m^2$ x 3.500 $m^2$/km
= $8,488.80/km

NOTE: This is the only hydroseeding cost considered because it is the maximum cost which can be incurred.

Now that each cost is expressed in cost/km, a comparison of each alternative's net present value of total cost for 15 years can be made.

This involves the use of a net present value table and an applicable discount rate. The discount rate used is the Treasury Board's Social Discount Rate - 10%.

Table C of this appendix lists the net present value of the associated total cost/km for 15 years for each alternative.

TABLE C: CALCULATION OF NET PRESENT VALUE * OF TOTAL COST PER KM FOR 15 YEARS

| Alternative | Initial | Drainage Cleaning $5,600/km | Resurfacing $96,000/km | Total Cost |
|---|---|---|---|---|
| I. Hydroseeding | $8,488.80 | Year 7 $2873.92<br>Year 14 1474.46<br>Add1** 108.08<br>Subtotal $4456.46 | Year 7 $49,267.20<br>Year 14 25,276.80<br>Add1 1,852.80<br>Subtotal $76,396.80 | $89,342.06 |
| IIA) Annual Ditch Cleaning | NIL | $5,600 x 7.6061 = $42,594.16 | (same as above) $76,396.80 | $118,990.96 |
| IIB) 3 Year Ditch Cleaning | NIL | Year 3 $ 4,207.28<br>Year 6 3,161.20<br>Year 9 2,374.96<br>Year 12 2,374.96<br>Year 15 1,340.64<br>Subtotal $12,869.00 | Year 6 $54,192<br>Year 12 30,585.50<br>Add2*** 11,491.20<br>Subtotal $96,268.70 | $109,137.70 |
| IIC) No Ditch Cleaning | NIL | NIL | Year 5 $59,606.40<br>Year 10 37,008.00<br>Year 15 22,982.40<br>$119,596.40 | $119,596.80 |

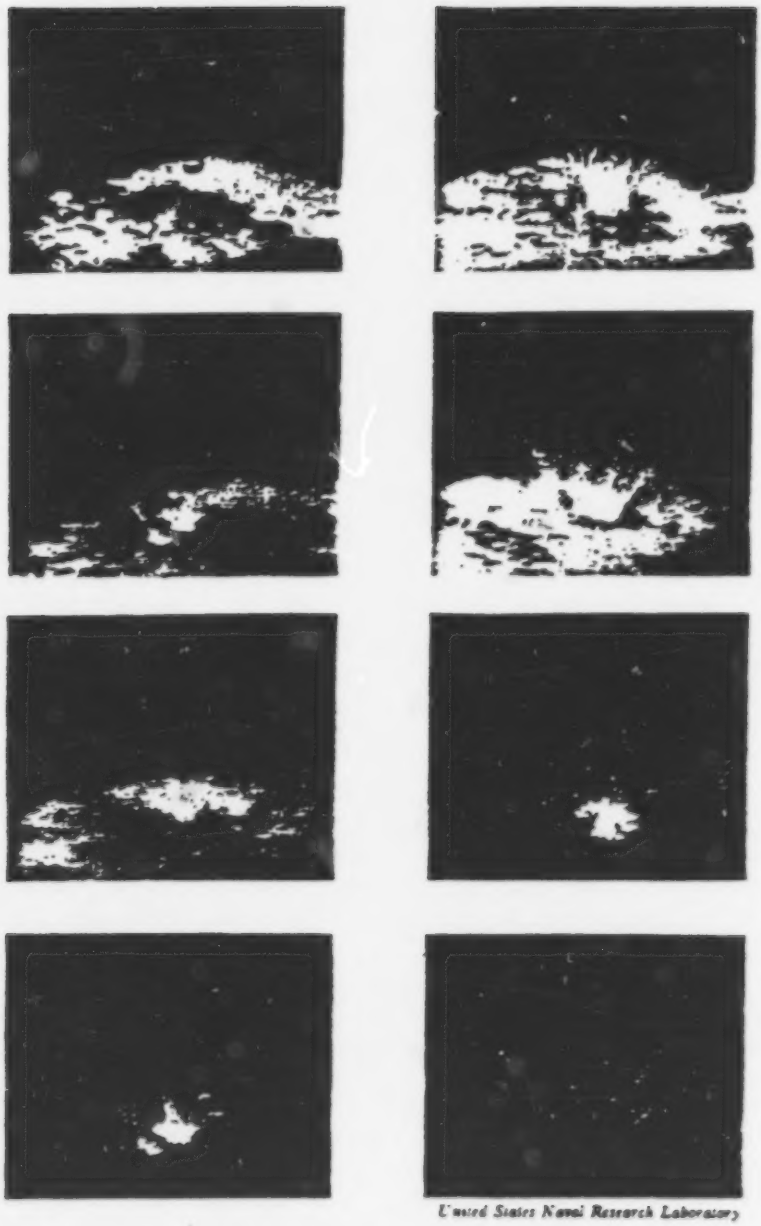
*i = 10%, Treasury Board Social Discount Rate
**add1 = 1/7 x amount from next drainage cleaning
***add2 = 1/2 x amount from next resurfacing

# APPENDIX C

RAINDROP SPLASH

Source: Bennett, Hugh Soil Conservation

# RAINDROP SPLASH



*United States Naval Research Laboratory*

Raindrops strike bare soil like small bombs, causing disintegration and erosion of the soil

## APPENDIX D

PHOTOGRAPHS OF SITE PRIOR
TO HYDROSEEDING

Source: Cynthia Brenton, Research Assistant
Department of Transportation

NOTE: For better visuals, original photographs can be obtained from the Planning and Research Library, Department of Transportation.

PHOTOGRAPHS OF SITE PRIOR TO HYDROSEEDING

## APPENDIX E

SOIL SAMPLING PROCEDURE USED BY THE
DEPARTMENT OF AGRICULTURE FOR AGRICULTURAL LAND

Source: Soil Laboratory, Department of Agriculture

## INSTRUCTIONS FOR TAKING SOIL SAMPLES

1. Sampling of the soil for testing by rapid chemical methods is an EXCEEDINGLY IMPORTANT part of the procedure. Single samples or samples not truly representative of the field in question are of LITTLE OR NO VALUE. Each sample submitted for testing should be a composite of 20 to 25 samplings well distributed over the field or area. The number of places from which soil is taken will depend upon the size of the field or area. See diagram No. 1.

2. In fields or areas having more than one distinct soil type, or important differences in past treatment or crop growth, separate samples should be taken from each part. Likewise, portions of a field which shown definitely poorer results than the average should be sampled separately.

3. When taking the sample, expose a clean face by cutting the soil vertically to full plow depth using a clean spade or trowel. Then take a thin slice (about 1 inch thick) to the full depth of the exposed face. In the case of permanent pastures and lawns, a 2 to 3 inch depth is sufficient. See diagram No. 2.

4. Avoid taking the sample from the fertilizer band when sampling fields in row crops. Avoid any unusual spots such as old fence or roadbeds, or where lime or manure has been piled or spilled. Also avoid small areas that are much different from the rest of the field. If desirable, these areas can be sampled separately.

5 The soil is easier to sample when its moisture condition is suitable for ploughing. If the field is being ploughed, a sample can be taken from either the side of the dead-furrow or the side of the turned sod, at several spots in the field.

6. Any clods or lumps should be broken up before they dry out. Fairly wet samples can be spread out to dry at room temperature on a clean sheet of new wrapping paper. Do not dry samples on a stove or radiator, or in the stable.

7. If using a sampling tube or soil auger, a pint carton will usually hold the soil from 20 to 25 spots. If this is not practical, as when using the spade, collect samples in a clean bucket, mix the soil from all spots well, then halve or quarter as necessary to fill a pint carton. Do not use unclean containers.

8. Label each sample with a number and your name. Be sure to keep a record of the area from which the samples were taken. One way is to make a rough sketch or map of the sampled areas.

9. Fill out the information sheet as fully as possible. This will help greatly to make your report and recommendations useful to you.

Return the completed questionnaire with the soil sample to the SOIL LABORATORY, BOX 7098, ST. JOHN'S WEST, NFLD. (RESEARCH STATION, CANADA DEPARTMENT OF AGRICULTURE).

Diagrams showing methods of sampling.

Diagram No. 1

Under-Soil
Diagram No. 2

# APPENDIX F

SOIL TEST REPORT

Source: Department of Rural, Agricultural and Northern Development

SOIL TEST REPORT
DEPT OF RURAL, AGRICULTURAL & NORTHERN DEVELOPMENT
PROVINCIAL AGRICULTURE BUILDING
BROOKFIELD ROAD
MOUNT PEARL, NFLD.
A1C 5T7

NAME : DEPT. OF TRANSPORTATION
ADDRESS : P O BOX 1651
ST. JOHN'S
NF A1C 5P3

DATE RECEIVED : 84 09 24
DATE REPORTED : 84 10 15
LAB NOS. : 597 - 598
UNIT CODE : 0
AGRIC. REP. : NOT APPLICABLE
SPECIALIST : NOT APPLICABLE

NOTE: SOIL TEST RATINGS AND REQUIRED NUTRIENT APPLICATIONS ARE FOR CROPS SPECIFIED. A CHANGE OF CROP WILL REQUIRE NEW SOIL TEST RATINGS AND MAY REQUIRE DIFFERENT NUTRIENT APPLICATIONS.

---

CROP : LAWN. FINE TURF
LAB NO. : 597
SOIL PH : 4.9
Marginal

AREA (HA) : 1
FIELD NO. : 1
LIME REQUIRED : 5 TONNES/HA

| | PHOSPHATE | POTASH | CALCIUM | MAGNESIUM |
|---|---|---|---|---|
| SOIL TEST VALUES (KG/HA) | 100 | 98 | 224 | 45 |
| SOIL TEST RATINGS | L- | L | L- | L+ |

| | NITROGEN | PHOSPHATE | POTASH |
|---|---|---|---|
| REQUIRED APPLICATIONS (KG/HA) | 165 | 280 | 160 |

SUGGESTED TREATMENT

APPLY 10 LBS. OF LIMESTONE PER 100 SQ. FT. OF LAWN.
IF LIMESTONE REQUIREMENT IS MORE THAN 15 LBS. PER 100 SQ FT., APPLY HALF NOW AND THE OTHER HALF NEXT SPRING OR FALL.
APPLY 2 LBS. OF 6 - 12 - 12 IN THE SPRING.
APPLY 1 LB. OF 12 - 6 - 3 PER 100 SQ. FT. OF LAWN LATE JUNE AND AGAIN MID-AUGUST.

---

CROP : LAWN, FINE TURF
LAB NO. : 578
SOIL PH : 4
P: AT

AREA (HA) : 1
FIELD NO. : 2
LIME REQUIRED : 8 TONNES/HA

| | PHOSPHATE | POTASH | CALCIUM | MAGNESIUM |
|---|---|---|---|---|
| SOIL TEST VALUES (KG/HA) | 55 | 14 | 134 | 159 |
| SOIL TEST RATINGS | L- | L- | L- | M |

| | NITROGEN | PHOSPHATE | POTASH |
|---|---|---|---|

| | | | |
|---|---|---|---|
| REQUIRED APPLICATIONS (KG/HA) | 165 | 280 | 180 |

UGGESTED TREATMENT

APPLY 16 LBS. OF LIMESTONE PER 100 SQ. FT. OF LAWN.
LIMESTONE REQUIREMENT IS MORE THAN 15 LBS. PER 100 SQ. FT., APPLY HALF NOW THE OTHER HALF NEXT SPRING OR FALL.
APPLY 2 LBS. OF 6 - 12 - 12 IN THE SPRING.
APPLY 1 LB. OF 12 - 6 - 3 PER 100 SQ. FT. OF LAWN LATE JUNE AND AGAIN IN AUGUST.

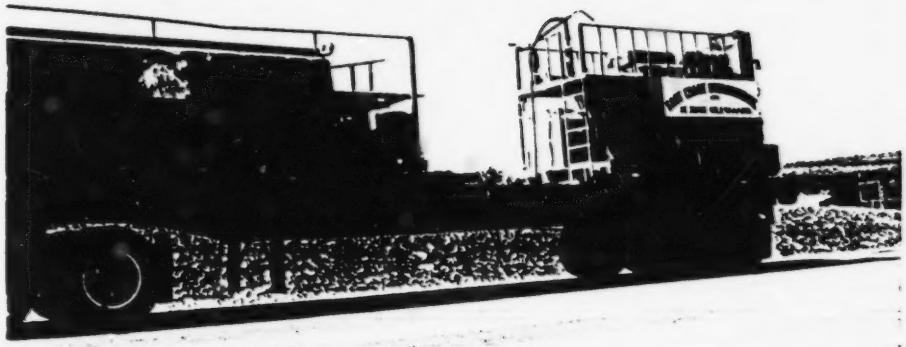
DONALD TRENHOLM, SUPERVISOR
SOIL & PLANT LABORATORY

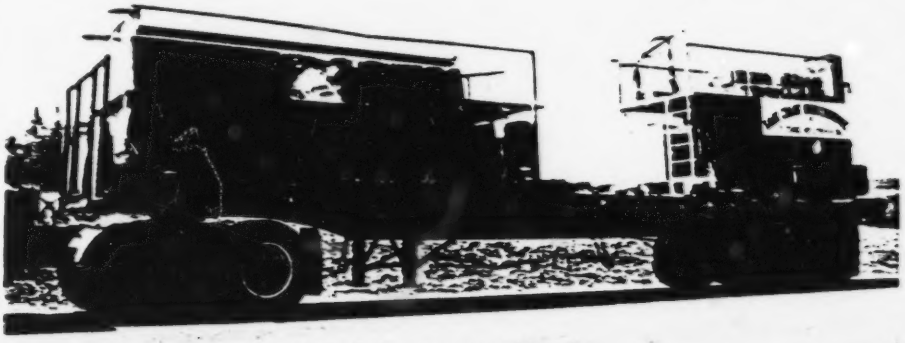
## APPENDIX G

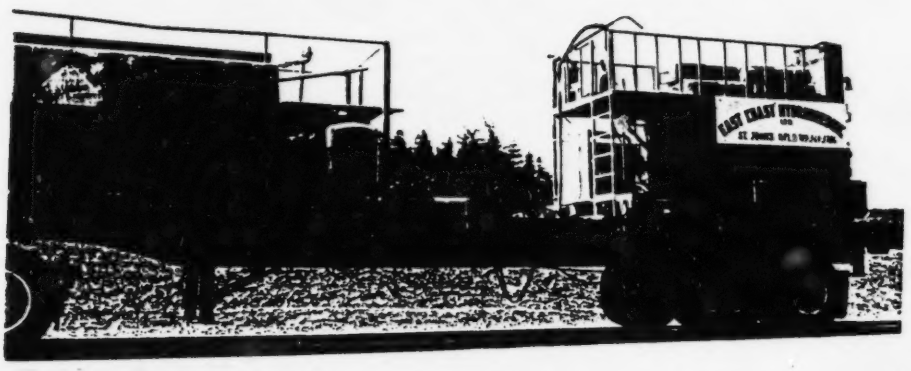
PHOTOGRAPHS OF HYDROSEEDING MACHINE

Source: Cynthia Brenton, Research Assistant
Department of Transportation

PHOTOGRAPHS OF HYDROSEEDING MACHINE





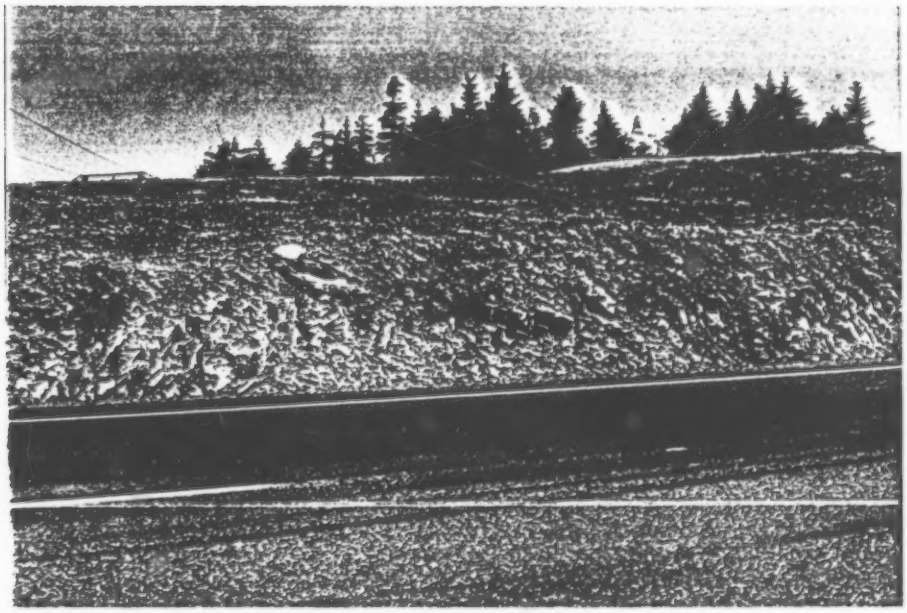

EAST COAST

## APPENDIX H

PHOTOGRAPHS OF SITE
AFTER HYDROSEEDING

Source: Cynthia Brenton, Research Assistant
Department of Transportation

PHOTOGRAPHS OF SITE AFTER HYDROSEEDING

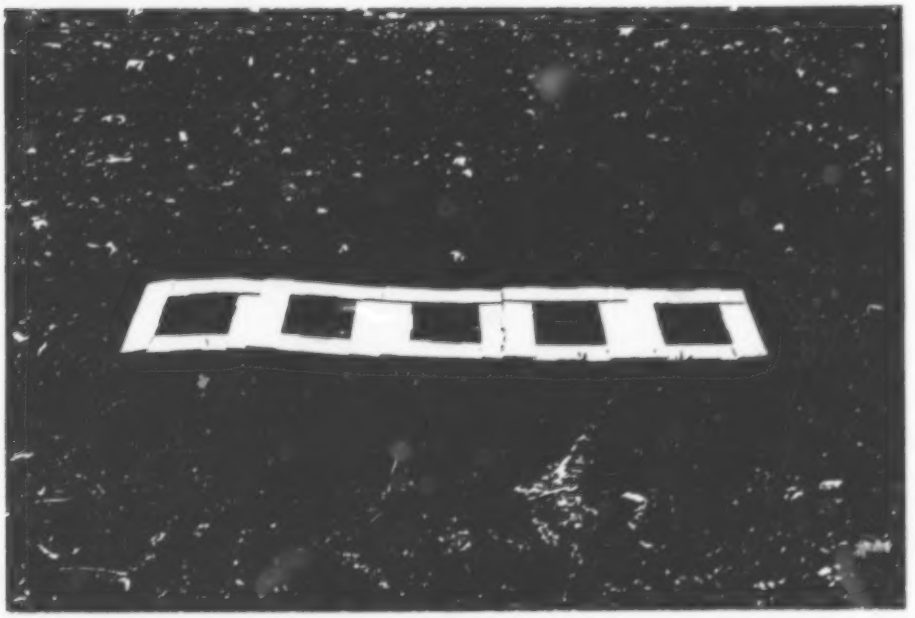


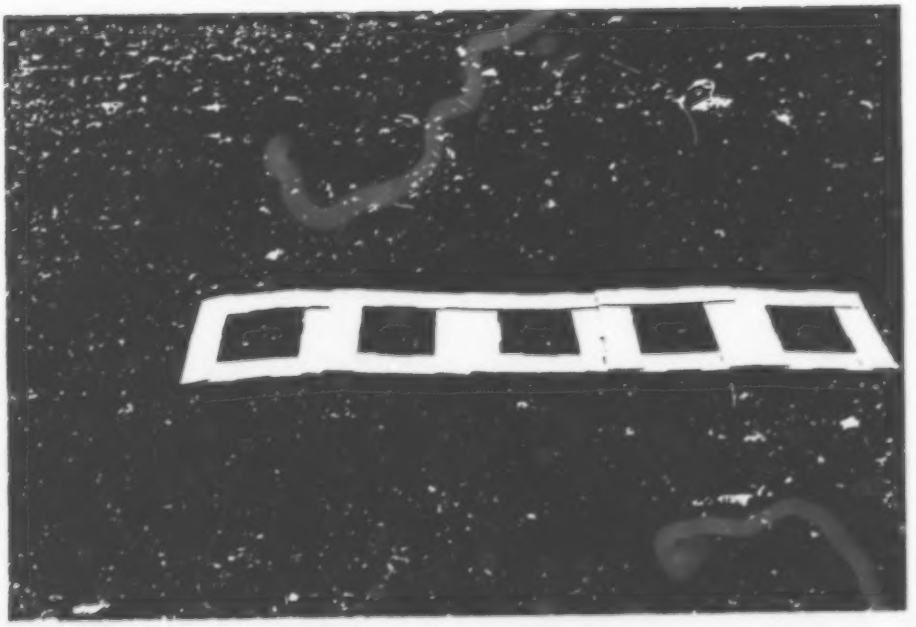
# APPENDIX I

PHOTOGRAPHS OF FRAME USED TO
ESTIMATE TURF GRASS COVER

Source: Cynthia Brenton, Research Assistant
Department of Transportation

PHOTOGRAPHS OF FRAME USED TO ESTIMATE TURFGRASS COVER





## APPENDIX J

PHOTOGRAPHS OF SITE AFTER
GRASS COVER IS ESTABLISHED

Source: Cynthia Brenton, Research Assistant
Department of Transportation

PHOTOGRAPHS OF SITE AFTER GRASS COVER IS ESTABLISHED